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ALTERNATE WETTING AND DRYING IRRIGATION FOR RICE CULTIVATION

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ABSTRACT

In the context of global energy crisis and water scarcity, the rice production system is undergoing changes, with the strategy to produce more rice with lesser amount of water. Impact of alternate wetting and drying (AWD) irrigation, as a water saving technique on rice yield has been overviewed in this paper. Rice was irrigated in continuous flood irrigation (CFI) method, maintaining 5 cm of standing water, throughout the cropping period. The experiment has revealed that, AWD method saved the irrigation water about 23%, over the continuous flood irrigation method. AWD is an irrigation practice (introduction of unsaturated soil conditions during the growing season), that can reduce water inputs in rice, yet, it has not been widely been adopted, due to the potential for reduced yields. Overall, AWD decreased yields by 5.4% (when soils dried beyond−20 kPa), compared to the continuous flood irrigation methods.

KEYWORDS: Alternate Wetting and Drying, Continuous Flood Irrigation & Rice Yield

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Original Article

INTRODUCTION

Rice is essential for ensuring global food security. Traditional rice cultivation, practiced in flooded paddy soils, demands higher water inputs than other cereal crops (Pimentel et al., 2004).

Water Scientists have developed technology for producing rice with less water. The technique is so-called “Alternate Wet and Dry” (AWD) method of irrigation, in which irrigation water is applied to obtain flooded conditions, after a certain number of days have elapsed after the disappearance of ponded water (Bouman *et al.,* 2007). The AWD technique considers rice crop like any other irrigated crop, with no standing water and maintaining an aerobic condition in the soil.

The concept is that, irrigation is applied in rice land to bring ponding conditions, after a certain period has elapsed after the ponded water has receded from the field (Sakthivadivel *et al.*, 2001,). The period of non-flooded condition may vary, depending on soil texture, but, normally that could be 2-3 days. AWD irrigation begins from 10-15 days after transplanting, or 20 days after direct seeding of rice.

Under AWD, fields are subjected to intermittent flooding (alternate cycles of saturated and unsaturated conditions), where irrigation is interrupted and water is allowed to subside, until the soil reaches a certain moisture level, after which the field is reflooded. AWD has been reported to reduce water inputs by 23% (Bouman and Tuong, 2001), compared to continuously flooded rice systems. In certain areas, and under the favorable conditions, AWD is a promising method in irrigated rice cultivation, with the dual benefits of water saving and human disease control, while maintaining rice yields at least in the same level. However, many factors play a role in determining

the success or failure of AWD. Through 31 field experiments, analyzed by Bouman and Tuong, (2001), 92% of the AWD treatments resulted in yield reduction.

Castaneda e*t al*. (2002) found that, under aerobic rice cultivation in China, water productivity was increased by 20-40%, when compared under flooded conditions, because, water use deceased relatively more than the yield. Intermittent irrigation required 27-37% less water than the flooded treatments, whereas grain yield increased by 4 to 6%.

Sakthivadivel *et al.* (2001), reviewed the effects of water saving techniques of irrigation (WSI) on rice yield, and water productivity in many countries. Studies done in the International Rice Research Institute (IRRI) revealed that, rice yield generally declined as soon as the field water content reached or dropped below saturation. Yield reduction was reported up to 10%, when the soil water was kept at saturation. The present study objective was based on the above inferences; we have also conducted both AWD & CFI experiments.

MATERIALS AND METHODS

This study was conducted at Agricultural engineering college and research institute, Tamilnadu Agricultural University (TNAU), Kumulur. The experimental plot size of 7 m × 5.7 m for each irrigation method, namely AWD and CFI, during the period from Dec 2016 to Mar 2017 was done. The Table 1 represents the physical and chemical properties of the experimental plot. Table 2 represents the crop details in both irrigation methods. Under AWD, when the soil, water potential was ≥ −20 kPa the experimental field irrigation was done.

Table 1: Physical and Chemical Properties of the Soil

Character/Property	Values
Sand (%)	68
Silt (%)	22
Clay (%)	10
Textural Class	Sandy loam
pH	8.1
Electrical Conductivity (dS m-1)	0.31

Table 2: Crop Details

SI. No	Particulars	Details
1	Crop	Paddy
2	Variety	CORH4
3	Duration	Medium
4	Seedlings per hill	One
5	Plant to plant spacing	20 cm
6	Row to row spacing	20 cm

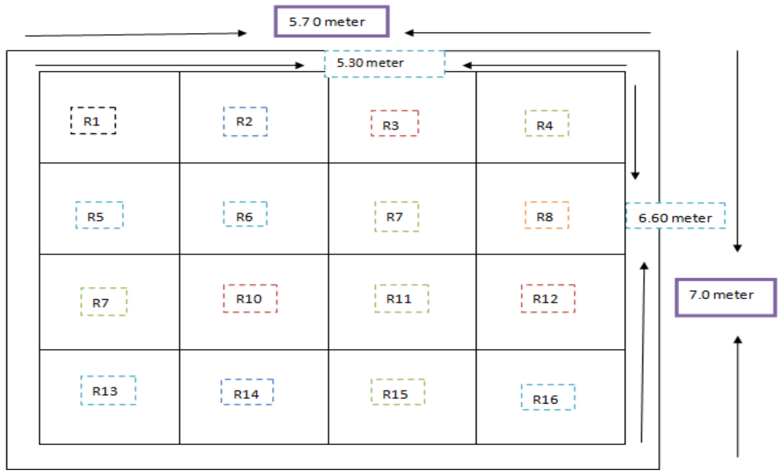

Figure 1: Field Layout of Rice Crop for each Irrigation Method

Figure 1, shows the layout of the crop field. The total area is 40 m^2 with the length is7 m and width is 5.7 m. We have neglected the outer 0.4 m from width and length. So remaining area has 35 m^2, with the length is 6.6 m and width is 5.3 m, that area is divided into equal for each 16 replication. The single replication has 1.65m length and 1.325 m width. So the total area of single replication is 2.18 m^2. Single replication consists of 48 plants. So, three samples are taken from each replication for taking observation data.

The experimental plots (7 m x 5.7 m) were laid out with single factor randomized block design (RBD), combining the two treatments of irrigation (alternate wetting and drying and continuous flood irrigation), it was replicated sixteen times.

The first treatment (T1) was AWD and (T2) was a CFI. Continuous standing water (5cm) was maintained in each treatment, up to 20 days after transplantation (DAT), to avoid pre apprehended weed infestation that could be awesome during the crop establishment stage. Quantitative information related to yield and its plant characters *viz.*, plant height, effective tillers, panicle, no. of filled and unfilled grains per panicle, 1000 grain weight, grain yield, straw yield were analyzed.

RESULTS AND DISCUSSIONS

Significant consequences of AWD and CFI, for the production of rice were observed as given in Table 3. The analyses show that, the effect on plant height was statistically significant at 5% probability level. The tallest plant (122.4 cm) was found in CFI (T2). The shortest plant (116.4 cm) was found in the AWD (T1). Variation in plant height could be, due to the difference in the water level. The highest number of total tillers hill^{-1} was found in CFI (21), and the lowest number of total tiller was found (18) in AWD. The highest length of panicle (19 cm) was found in (T2), whereas the lowest length of panicle was (17 cm) in (T1). Filled grain was statistically significant at 1% probability level. The results show that, the highest filled grain yield (2748) was achieved from (T2), whereas the lowest filled grain yield (2600) was achieved from (T1). The highest number of unfilled grains panicle^{-1} (923) was found in (T1), whereas the lowest number of unfilled grains panicle^{-1} (895) was found from (T2). The result shows that, the highest weight of 1000- grain (20.85g) was obtained from AWD. The low weight of 1000-grain (19.56g) was obtained from CFI**.** Grain yield was statistically significant, at the 5 % level of probability. The highest grain yield (8.74 t/ha) was achieved from CFI. The lowest grain

yield (8.25 t/ha) was achieved from AWD. These differences occurred, due to variations of water stress. The result shows that, the highest straw yield (11.98 t/ha) was found from CFI. The lowest straw yield (8.464 t/ha) was found from AWD. The highest yield occurred, due to higher plant height, higher total tiller hill^{-1}, number of panicle, filled grain per plant and lower number of unfilled grains per plant.

Table 3: Effect of Different Irrigation Treatments (AWD & CFI Irrigation) on the Yield and Yield Contributing Characters

Treatment	Plant Height (cm)	Tiller per Hill	Number of Panicle	Filled Grain per Plant	Unfilled Grain per Plant	1000 Grain Weight(gm)	Grain Yield t/ha	Straw Yield t/ha
T_1	116.4	18.6	17.3	2600	923	20.85	8.25	8.464
T_2	122.4	20.2	19	2748	895	19.56	8.74	11.980
LSD	0.022	0.037	0.052	0.001	0.657	0.240	0.019	0.037
Level of significant	*	*	*	**	NS	NS	*	NS

T_1= Alternate wetting and drying irrigation, **T_2** = Continuous flood irrigation, NS = Not Significant, * = Significant at 5% level of probability, ** = Significant at 1% level of probability, LSD= least significant difference.

CONCLUSIONS

In order to promote the rice cultivation in water scarcity areas, generally AWD method is adopted. A number of constraints and issues at national, regional and local levels have to be solved, as suggested by the findings. This experiment also indicated that, Water Productivity Index increased and that, land productivity (*i.e.*, yield per unit of land) did not differ much from conventionally adopted flood irrigation. This field experiment confirms that, AWD is a sustainable method in irrigated rice cultivation, with benefits on water saving and maintaining the productivity comparable to conventional flood irrigation. Under AWD, when the soil, water potential was ≥ -20 kPa, yields were not significantly reduced in most circumstances. The result obtained, such as yield and the plant characters viz., plant height, effective tillers, panicle, number of filling grains were higher in (T2) and unfilled grains per panicle, 1000 grain weight and straw yield was higher in (T1). Experiments and field survey of the AWD method of cultivating rice from different parts of the world, have demonstrated the utility of AWD for water saving in irrigated rice cultivation. The present study has revealed that, AWD method saved about 23% of irrigation water, over the continuous flood irrigation method.

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